REMARKS/ARGUMENTS

Claims 1-7, 12, 13, 16, 17, 19 and 25-50 were pending in the application. Claims 7, 12-13, 17, 19, 28, and 40 have been canceled. Claims 1, 6, 25, 39, 44, and 48 have been amended. Claims 30-38 have been allowed. All other claims have been resubmitted.

The Examiner rejected Claims 1-2, 4-5, 7, 26, and 43 under 35 U.S.C. Section 102(b) as being anticipated by Petzoldt *et al.*

The Examiner also rejected Claims 1-5, 7, 25-27, 29, 39 and 41-50 under 35 U.S.C. Section 103(a) as being unpatentable over International Application WO 98/54531 A1.

The Examiner also rejected Claims 3, 16, 19, 27, 41-42, 44-46, and 48 under 35 U.S.C. Section 103(a) as being unpatentable over Petzoldt *et al.*

The Examiner also rejected Claim 6 under 35 U.S.C. Section 103(a) as being unpatentable over Petzoldt *et al.* and WO 98/54531 in view of Marder, Arnold (Arnold R. Marder "*Effects of Surface Treatments on Material Performance: Deposition Surface Treatments*," ASM Handbook, Vol. 20, 1997, pp. 1-18).

The Examiner also rejected Claims 12-13, 17, 19, and 28 under 35 U.S.C. Section 103(a) as being unpatentable over Petzoldt *et al.* and International Application WO 98/54531 A1 in view of Reedy, Jr.

The Examiner also rejected Claim 16 under 35 U.S.C. Section 103(a) as being unpatentable over Petzoldt *et al.* and International Application WO 98/54531 A1 in view of Reedy, Jr.

The Examiner allowed Claims 30-38. The Examiner objected to Claim 40, which would be allowable if rewritten in independent form.

Amendments to the specification

The Examiner noted that the amendment to the specification included in the amendment filed on October 30, 2003 has not been entered, because the amendment was non-compliant. Applicant resubmits the amendments to the specification herewith, with additional amendments to paragraphs [031] and [036].

The Examiner objected to the disclosure because the status of the US patent application cited on page 8 needed to be updated. Paragraph [031] on page 8 has been amended to update its status; it is now "U.S. Patent No. 6,670,050, issued on December 30, 2003."

Paragraph [035] has been amended to add the sentence: "The aluminum conversion layer may be deposited on the titanium-based substrate at a temperature of less than about 450° C." Support for this amendment may be found in the original claims (e.g., Claim 6).

Paragraph [036] has been amended to correct informalities and to delete "the type of equation which gave the best fit ..." to be consistent with the drawings.

Paragraph [041] has been amended to change "lower" to "higher." Support for this amendment may be found at page 11, lines 13-17, and within paragraph [041] itself.

No new matter has been added.

Amendments to the drawings

In FIGs. 2 and 5, informalities in the figure titles have been corrected. No new matter has been added.

Allowable subject matter

The Examiner stated that Claim 40 would be allowable if rewritten to include all of the limitations of the base claim and any intervening claims. Claim 39 has been amended to include all of the limitations of Claim 40, and Claim 40 has been canceled.

Claims 41 and 42 depend from Claim 39, which is now in allowable form. Claims 41 and 42 have been resubmitted.

Support for amendments to the claims:

Support for the amendment of Claims 1 and 25 can be found, for example, on page 6, lines 12-13 of the specification.

Support for the amendment of Claim 44 and 48 can be found, for example, on page 9, line 20 of the specification.

Support for the amendment of Claim 6 can be found, for example, on page 9, line 15 of the specification.

Claim rejections – Petzoldt *et al.*, 35 U.S.C. 102(b)

The Examiner rejects Claims 1-2, 4-5, 7, 26, 39, and 43 under 35 U.S.C. 102(b) as being anticipated by Petzoldt.

After reviewing the Examiner's comments, Applicant still believes that the present invention pertains to a process and product different from Petzoldt.

Pretzoldt describes an ion deposition process that produces a titanium aluminide coating. Oxidation and corrosion protection is provided by this titanium aluminide.

In contrast, the process in the present application deposits an aluminum coating that then forms by heat treating a continuous dense alumina coating and subsequently below the alumina a titanium aluminide coat, as in amended Claim 1. Alumina offers superior oxidation resistance than titanium aluminide, the oxidation resistance of which depends on the type of titanium aluminide formed –TiAl TiAl3 etc.

US 5300159 to Petzold provides few details of the ion coating. It appears that many of the details are in US 3,329,601 to D.M. Mattox, which is incorporated into Petzoldt (column 2 line 60).

Mattox explains that the energy in ion vapor deposition gives a high surface temperature without the need for external heating (column 2 line 50). The temperature rise may be controlled by using very slow deposition rates, which limits the thickness of the coating, as only a thousand Angstroms per hour is typically deposited. This is important as the heating is sufficient to melt the surface of the substrate the coating is being deposited upon (column 2 line 10-15). In US 3,329,601 a cooling probe is placed behind the substrate to limit its temperature rise and allow deposition rates which are commercially viable to be used (see for instance column 6 line 20 -30). Placing the cooling probe or

plate behind the sample will only allow the bulk temperature to be reduced and will not avoid the coated surface reaching a high temperature, as Mattox indicates that a high temperature is required to achieve a good coating. Column 6 line 20-30 also indicates that even the bulk temperature may be substantial allowing undesirable phase changes etc. if the coating rate is not controlled.

Further, Mattox indicates that the cleaning process prior to coating also heats the surface of the substrate and activates it to be ready to react with the coating, and that this is an important part of ion vapor deposition (column 4 line 65-70).

Furthermore, Mattox indicates that these heating problems are even more pronounced when coating aluminum (column 5 line 50 –55). Higher current densities are required for Al and hence even higher surface temperatures are obtained.

Neither Mattox nor Petzoldt measure the surface temperature, but as they make reference to surface melting and undesirable phase changes in the bulk substrate we must assume that the temperatures are metallurgically speaking high, especially if economical deposition rates are used. Petzoldt also mentions that several different titanium aluminides are formed, Ti3Al and TiAl, as well as TiAl3, confirming that the part has seen high temperatures. We can then assume that the Al deposited by Petzoldt will directly form a titanium aluminide. (Mattox further states that if the temperatures are low the coating is not bonded to the substrate. Hence free aluminum will only be present if it is not bonded to the Ti, i.e., it has not formed a coating.)

In contrast, the deposition process in the present invention is carried out at a low temperature so that the deposited aluminum does not directly form a

titanium aluminide, as clarified in the amended Claim1. Note that the titanium aluminide layer is formed as a result of the heat treatment in the present invention, not during deposition.

The Examiner rejects Claims 1-2, 4-5, 7, 26, 39, and 43 under 35 U.S.C. 102(b) as being anticipated by Petzoldt. However, as explained above, Petzoldt teaches a deposition at temperature forming TiAl during the deposition.

In contrast, the present application claims deposition at a low temperature at which there is no reaction between the Ti and Al (amended Claim 1)

Further, Applicant submits that the Examiner stated incorrectly that the ions of Petzoldt are equivalent to the gaseous atmosphere of Claim 4. Ions require a vacuum, i.e. less than 1 atmosphere, while a positive pressure is plus 1 atmosphere. This is important as a gaseous atmosphere allows us to uniformly coat a complex part like a heat exchanger.

Applicant has already indicated that the process described by Petzoldt cannot coat a complex shape, such as a heat exchanger, because it is line of sight limited. Applicant adds that for a part such as a heat exchanger it is not possible to directly cool the part with a "cold finger" as described by Mattox and used by Petzoldt; therefore, the deposition rates would be uneconomical, even if we found a way to coat the part, using line of sight techniques.

The Examiner stated that the two step process in the present application is used by Petzoldt. This is not the case as explained above in that Petzoldt forms TiAl directly and does not form Al2O3 and then a TiAl. The Examiner cited Petzoldt column 4 line 37-38 as using an oxidizing step. However, this appears to be the testing of the part in an oxidizing environment. The coated

parts and an uncoated were tested in air at 1650F (the use temperature for the super plastic forming tools). The uncoated test panel formed scale the coated ones did not - line39. The panels were then subjected to a further nine oxidation cycles, line 42-43 and showed no scaling.

In contrast, our process involves oxidation to form Al_2O_3 prior to forming the titanium aluminide, as in amended Claim 1. Generally, once the titanium aluminide is formed by any process, there will be no free Al left to form Al_2O_3 unless the Al is not bonded to the Ti.

Accordingly, Claim 1 should be allowable over Petzoldt as amended. Claim 7 has been canceled. Claims 2, 4-5, and 26 depend from and further limit Claim 1, and should also be allowable for at least the same reason. These claims have been resubmitted.

As for Claim 43 (the product), the Examiner stated that the product is not different from that described in the prior art. As described above, Petzoldt carries out an ion coating technique which results in the formation of different titanium aluminides during coating. This is an uncontroled process. There is no Al_2O_3 layer associated with his process. Indeed Petzoldt describes steps to remove any excess Al (column 3 line 57-60) that could form such a Al_2O_3 layer. This is understandable as any excess Al would according to Mattox be poorly bonded to the substrate.

In contrast, in the present application, we deposit Al at a temperature at which it does not react with Ti (as in amended Claims 1 and 25), we then oxidize the Al to form a dense continuous Al_2O_3 layer and then heat the part at a precise temperature so that $TiAl_3$ is formed below the Al_2O_3 (as in amended Claim 1). In fact, the $TiAl_3$ can be considered a kind of bonding layer. This results in a two layer coating (as in Claim 44) rather than a one layer coating as

described by Petzoldt. The benefit is superior oxidation resistance and also a minimal impact on ductility and fatigue properties, which Applicant describes in the application.

These differences in processing steps are also important as the heat exchanger is made up of brazed coated parts. The protective coating must be able to protect this braze as well as the Ti. The braze often contains less than 50% Ti and may contain no Ti, as described in paragraph [012] in the specification.

This is not possible with Petzoldts approach. In contrast, by forming the Al2O3 layer and then heat treating to allow the excess Ti to diffuse into the braze, forming a bond type layer is possible with the present approach, i.e., no titanium aluminide is formed, or it is not continuous and uniform.

The different processing steps do therefore result in a different product from the prior art and the product in Claim 43 has different and superior properties. Claim 43 should be allowable at least for this reason. In addition, please note that Claim 43 depend from Claim 36, which has already been allowed by the Examiner.

<u>Claim rejections – WO 98/54531 A1, 35 U.S.C. 103(a)</u>

Claims 1-5, 7, 25-27, 29, 39, and 41-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over WO 98/54531.

Applicant submits that, based on WO98/54531, one normally skilled in the art would not anticipate that the use of thinner Al coatings and lower heat treatment temperatures would result in superior properties, as in the present invention. Moreover, one skilled in the art would not have anticipated the

combination of parameters taught in WO 98/54431 would improve oxidation resistance, while avoiding the reduction in ductility and fatigue properties.

In addition, in view of the fact that coatings are well known to result in a fatigue debit it was also far from obvious that any approach based on a coating could result in a minimal impact on fatigue. See for instance the well-documented reduction in fatigue properties associated with anodized coating on aluminum.

The process modifications to WO 98/54531 may therefore be small and subtle, but they are non-obvious and result in a superior product which it was not obvious could be obtained, more especially in view of the process and product described in WO 98/54531.

WO 98/54531 therefore fails to teach or suggest all of the elements in Claims 1 and 25. Accordingly, Claims 1 and 25 should be allowable over WO 98/54531 as amended. Claim 7 has been canceled. Claims 2-5 and 26-27 are dependent from and further limit Claim 1. Claim 29 is dependent from Claim 25 and further limit Claim 25. Claims 43-50 are product-by-process claims based on the process different from prior art as discussed above. Thus, these claims are resubmitted.

Claim rejections – Petzoldt *et al.*, 35 U.S.C. 103(a)

Claims 3, 16, 19, 27, 41-42, 44-46, and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Petzoldt.

As discussed earlier in the Petzoldt section, the present invention uses a gaseous atmosphere which allows us to uniformly coat a complex part like a heat exchanger. In contrast, as Applicant has already discussed, the process

described by Petzoldt cannot coat a complex shape such as a heat exchanger, because it is line of sight limited. Claims 44 and 48 have been amended to include the "uniformity" as a superior structure of the product.

As discussed earlier in the Petzoldt section, Petzoldt fails to teach or suggest all the elements in these claims. Accordingly, Claims 3, 44-46, and 48 should be allowable and are resubmitted. Claims 16, 19, and 27 have been canceled.

Claim rejections – Petzoldt et al. and WO 98/54531 A1 in view of Marder, 103(a)

Claim 6 was rejected under 35 U.S.C. 103(a) as being unpatentable over the above references. Claim 6 has been amended as above.

Claim rejections – Petzoldt et al. and WO 98/54531 A1 in view of Reedy, Jr., 103(a); Petzoldt et al. in view of Reedy, Jr., 103(a)

Claim 12-13, 16-17, 19, and 28 were rejected under 35 U.S.C. 103(a). These claims have been canceled.

CONCLUSION

Applicant submits that the claims are now in condition for allowance.

Reconsideration and withdrawal of the Office Action with respect to Claims 1-6, 25-27, 29, 39, 41-50 are requested.

In the event the examiner wishes to discuss any aspect of this response, please contact the attorney at the telephone number identified below.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450

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